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March 31, 2011

Steven Way
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Mail Code: 8EPR-ER
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SUBJECT: START 3, EPA Region 8, Contract No. EP-W-05-050, TDD No. 1005-01, Sampling and Analysis Report, Rico-Argentine St. Louis Ponds, Rico, Dolores County, Colorado

Dear Steve:

Enclosed are three copies of the final Sampling and Analysis Report for the Rico-Argentine St. Louis Ponds site. The report presents the field and analytical data for surface water, pore water, sediment, and soil samples that were collected at the site from November 15 through 17, 2010. This report is submitted for your review and approval.

If you have any questions, please call me at 720-810-0759.

Very truly yours,

URS OPERATING SERVICES, INC.

Chul W. Bl FOR

Jan Christner, P.E.
Environmental Engineer

cc: Charles W. Baker/UOS (w/o attachment)
File/UOS

Steve

START 3

Superfund Technical Assessment and Response Team 3 – Region 8

United States
Environmental Protection Agency
Contract No. EP-W-05-050

SAMPLING AND ANALYSIS REPORT

RICO-ARGENTINE ST. LOUIS TUNNEL
Rico, Dolores County, Colorado

TDD No. 1005-01

MARCH 31, 2011

URS
OPERATING SERVICES, INC.

In association with:
Garry Struthers Associates, Inc.
LT Environmental, Inc.
TechLaw, Inc.
Tetra Tech EMI
TN & Associates, Inc.

RICO ARGENTINE ST. LOUIS TUNNEL SAMPLING AND ANALYSIS REPORT
Rico, Dolores County, Colorado

EPA Contract No. EP-W-05-050
TDD No. 1005-01

Prepared By:

URS Operating Services, Inc.
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Approved: ______________________ Date: 4/6/11
Steven Way, On-Scene Coordinator, EPA, Region 8

Approved: ______________________ Date: 3/31/11
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Approved: ______________________ FOR Date: 3/31/11
Jan Christner, Environmental Engineer, START 3, UOS

DISTRIBUTION LIST

U.S. ENVIRONMENTAL PROTECTION AGENCY

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RICO ARGENTINE ST. LOUIS TUNNEL
SAMPLING AND ANALYSIS REPORT
Rico, Dolores County, Colorado

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1.0 INTRODUCTION

URS Operating Services, Inc. (UOS) was tasked by the U.S. Environmental Protection Agency (EPA), Region 8, under Superfund Technical Assessment and Response Team (START) Technical Direction Document (TDD) No.1005-01, to assist in evaluating the Rico Argentine St. Louis Tunnel site north of Rico, Dolores County, Colorado (Figure 1). Among other features, the site contains a discharging mine and ponds associated with historic mine operations and water treatment. Mine discharge currently flows through the ponds and enters the Dolores River at the pond system outfall downstream of Pond 5 (Figure 1).

The current sampling was performed to meet the following objectives:

1. Determine if heavy metals and other contaminants are being released from the St. Louis Tunnel site at critical concentrations and flows during lower flow conditions in the Dolores River that currently or could be predicted to impact water quality or other environmental features during low flow.
2. Determine if the releases are contributing to degradation of water in the Dolores River.
3. Determine the load of metal contaminants contributed by the St. Louis Tunnel site to the Dolores River.
4. Determine the change in metals concentrations between the ponds to determine relative metals removal.
5. Determine differences in flow from the adit to the outfall and identify locations in the pond system where losses to groundwater or the Dolores River occur.
6. Identify other site materials that may contain hazardous substances and, under current conditions or if disturbed during site construction operations, may contribute to the potential for additional contaminant loading to the Dolores River.

This Sampling and Analysis Report (SAR) describes data and sample collection performed from November 15 through 17, 2010. Surface water was collected from the Dolores River upstream and downstream of the site and from the individual pond outfalls. Surface water and pore water was collected from a wetland channel and seep between the site and the Dolores River. Sediment was collected in select ponds. Soil was sampled north of Pond 18 and on the berm between Ponds 13, 14, and 15. The sample locations were located with Global Positioning System (GPS) equipment and photographed (Figure 1; Appendix A). Water was analyzed in the field for pH, temperature, and conductivity. Water samples were analyzed for total and dissolved metals, hardness, and alkalinity. Soil and sediment samples were analyzed for total metals. Work was conducted in accordance with the Sampling and Analysis Plan (SAP) except as noted in this report. Two UOS personnel and EPA On-Scene Coordinator Steven Merritt completed the work. An EPA Environmental Services Assistance Team (ESAT) contractor collected the co-located surface water and pore water samples.

This report presents site background (Section 2), describes the field activities and exceptions from the SAP (Section 3), and presents and discusses the analytical results Section 4. Recommendations for follow-up activities are presented in Section 5.

2.0 BACKGROUND

The Rico Argentine Mine Site – Rico Tunnels (Site) was historically used for mining and material processing. Mining in the Rico area, known as the Pioneer District, began in 1869 and continued sporadically over the next century. Significant mining began at the site in the early 1900s. The St. Louis tunnel was driven during 1930 and 1931, and several expansions in subsequent years have connected the St. Louis Tunnel to other mine workings in the area. An acid generation plant was operated at the site beginning in the 1950s, and a leach heap was operated at the northwest portion of the property during the mid-1970s. Mining or exploration continued into the mid-1980s. The acid plant and associated structures were demolished and the site was regraded, capped with a soil cover, and revegetated during 1985 and 1986 (Atlantic Richfield Company [AR] 2010).

A series of ponds was installed at the site by 1956 and additional ponds were added by 1979. At least some of the ponds were initially used in the production of sulfuric acid from pyritic ore and tailings. More recently, the ponds have received mine impacted water that discharges from the St. Louis Tunnel and contains elevated concentrations of metal contaminants. The ponds, constructed in the Dolores River floodplain, are unlined and were apparently constructed of materials available on site, including natural alluvial and colluvial deposits and waste rock. The ponds and associated hydraulic controls (culverts, overflow weirs, and standpipes) are not known to have been designed or constructed to a set standard of practice. It is unknown if or how the foundations were prepared, and current foundation conditions are unknown. The embankments are steep and some may be at the angle of repose for the material. Some of the embankments have been impacted by beaver activity, and pond contents have occasionally spilled into the floodplain (AR 2010). Water is believed to seep from the ponds into the groundwater and alluvium, and one study indicated a 40 percent loss of water through the pond system (Paser 1996). A seep was observed at the base of Pond 18 during September 2010, and the freeboard in Pond 18 was observed to be approximately 1 foot (URS 2010). The ponds currently contain a significant amount of sludge from the water treatment process (Paser 1996). Many of the ponds contain wetland vegetation.

In 1984, a slaked lime water treatment system began operation to treat the water with lime to increase pH and precipitate metal contaminants. The treated water flowed through the ponds where the metal precipitate was allowed to settle before the water was discharged to the Dolores River. The system was pennitted by the State of Colorado under Colorado Discharge Permit System (CDPS) permit number CO-0029793. Water treatment ceased in the mid-1990s, but water has continued to flow through the ponds.

The primary contaminants of concem in the tunnel discharge at this time are cadmium, copper, lead, manganese, and zinc; however, other metals may also be of concem. Data gathered by AR from 2000 through 2004 indicate that contaminants continued to be attenuated in the pond system after the discontinuation of treatment in the 1990s, but the pond system outfall concentrations were generally greater than those allowed by the CDPS permit. EPA sampled the tunnel discharge and the pond system outfall in June 2010, and the concentrations of some metals were significantly higher at the outfall than were seen in samples collected for AR from the early to mid-2000s. Although comparison of results is complicated by expected seasonal variations and variations in run-off events, a preliminary review of the data indicates a trend towards increasing concentrations being discharged from the ponds to the river (UOS 2010). Natural attenuation allows a limited amount of continued passive treatment in the ponds, but the ability of passive treatment in the existing pond system to reduce metal concentrations such that state water quality standards (WQS) are met in the Dolores River is in question.

Contaminant loading to the Dolores River occurs as mine water exits the pond system at the outfall from Pond 5, seeps from the settling ponds, or potentially overtops the settling ponds. Additional contamination may be introduced as runoff water contacts contaminated site soils and flows directly or through the ponds or alluvium to the Dolores River. There is also a risk that the ponds may be breached during flooding or storm events and release contaminants from the pond sediments and water into the river. The Site is releasing hazardous substances at high concentrations relative to water quality standards in the Dolores River such that water quality and environmental receptors may be impacted.

Based on an EPA removal evaluation and discussion with AR, actions were implemented by AR in late October 2010. The mine discharge was diverted directly into Pond 15, bypassing Pond 18, to allow Pond 18 to drain, to lower the outlet structure from Pond 18 to increase the available freeboard in the pond, and settle the sludge. The amount of treatment that occurs in each pond is unknown at this time; therefore, the effect of eliminating Pond 18 from the treatment system is unknown. A new water treatment system is being planned to treat mine discharge at the site. Construction of the new system may include the use of currently empty ponds. The berms and sediment of the unused pond (Pond 13) are reddish and of unknown quality.

3.0 FIELD ACTIVITIES

Field work, including sampling, field water quality measurements, flow measurements, and site documentation (GPS measurements and photographs), was accomplished from November 15 through 17, 2010. A snowstorm occurred on November 15 and the weather remained cold throughout the sampling trip.

Work was performed in accordance with the SAP with the following exceptions:

- Surface water samples collected from the Dolores River were re-named based on uncertainty in previously sampled locations for DR-1 and DR-7.
- Additional water samples were collected in the Dolores River to assist EPA in determining an appropriate mixing zone.
- Flow rates between ponds were not measured and a loading analysis was not performed.
- Surface water samples in the mixing zone location 110 feet downstream of the pond system outfall were collected from ¼, ½, and ¾ of the distance across the river rather than at 2 foot intervals.
- The sample collected from the bottom of Pond 13 was labeled as a soil sample (SLSO13) because the pond was empty.

3.1 SAMPLING

The following samples were collected on November 16 and 17.

- Surface water was sampled at the adit discharge flume, the pond system outfall flume, at each pond outfall location, and in the Dolores River upstream and downstream of the site.
- Co-located surface water and pore water samples were collected from four locations along the river side channel that flows through the wetland between the site and the Dolores River and from a seep at the base of the rip rap bank near the south end of Pond 15.

- Sediment samples were collected from the southeast corner of Pond 18, Pond 15 immediately north of the inflow pipe, the Pond 15 and Pond 10 water sample locations, the bottom of pond 13 (currently empty), and Ponds 2, 4, and 5.
- Soil samples were collected from fresh soil located north of Pond 18, and from the berm located between Ponds 13, 14, and 15. The sample from the bottom of Pond 13 was initially classified as a soil sample because Pond 13 did not contain water but is discussed as a sediment sample in this report.
- Duplicate samples were collected for quality assurance/quality control (QA/QC).

Figurer 1 shows sample locations, and Table 1 presents the sampling rationale and location descriptions. Appendix A provides photographs of the sample locations.

3.2 FIELD PARAMETERS

Field parameters, including pH, temperature, conductivity, and total dissolved solids were measured using a PCS Testr 35 multimeter and Table 2 presents the results. Measurements at the co-located pore water and surface water sample locations were made with the ESAT In-Situ Troll 9500, and some of the pond system pH measurements were duplicated with this instrument. Field parameters were not measured at sample location SLSW05/SLPO05 because the water was too shallow.

3.3 SURFACE WATER FLOW MEASUREMENT

Flow in the Dolores River was measured using a Marsh McBirney flow meter. Measurements in the Dolores River were complicated by the presence of large boulders in the stream. Flow at the adit discharge measuring point and the pond system outfall (DR-3 and DR-6) was measured using the existing 9-inch Parshall flumes. Flow between ponds was not measured due to inclement weather. Flow rate measurements are shown below.

Location	Flow Rate (cubic feet per second)	Flow Rate (gallons per minute)
DR3*	1.49	671
DR6*	1.43	642
DRBG+	20.1	--
DR7b+	15.9	7,140

* indicates flow measured by 9-inch Parshall flume; + indicates flow measured by Marsh McBirney

The data show that the flow at upstream location SLDRBG is greater than the flow at SLSWDR7b. While a review of historic flow data indicates this has occurred in the past, this result is suspicious because a significant amount of water, including the pond system outfall and water from the wetland area south of Pond 5, flows into the Dolores River downstream of the SLDRBG location, and there are no obvious outflows. Of the two river flow measurements, the measurement from the upstream (SLDRBG) location is more likely to be incorrect due to the presence of many large boulders in the channel. The flow measurement at SLSWDR7b was made at a location with fewer boulders and more laminar flow; therefore, the flow for the Dolores River at SLDR7b was considered more accurate and was used in evaluations in Section 4.

U.S. Geological Survey (USGS) gauging station 09165000 is located downstream of Rico and, when compared to relative flows immediately downstream of the pond system outfall, could be considered a check on the flow measurements. There are no flow values for the gauging station during the days of sampling, and flow measurements were limited by ice shortly thereafter (USGS 2011).

3.4 CONDUCTIVITY SCREENING

Conductivity screening was performed to assist in identifying potential sources of contamination along the Dolores River and the river side channel that flows through the wetland west of the site. Conductivity screening was also performed to identify the Dolores River mixing zone downstream of the pond system outfall. Conductivity readings were elevated in downstream portions of the river side channel in the wetland west of Pond 18, in the Dolores River at the confluence with the river side channel, and in the Dolores River downstream of the pond system outfall. Three samples were collected across the river at sample location SLDRMZ1 because the conductivity varied significantly across the river. Only one sample was collected at SLDRMZ2 and SLSWDR7b due to the uniform conductivity across the river.

4.0 ANALYTICAL RESULTS AND DISCUSSION

Surface water and pore water were analyzed for total and dissolved metals, hardness, and alkalinity, and Tables 3 and 4 present the results. Soil and sediment samples were analyzed for total metals. Table 5 presents the results of soil and sediment analysis. Tables 6 through 8 present the results of QA/QC samples. Sample analysis was performed at the EPA ESAT Laboratory, 16194 West 45th Drive, Golden, Colorado 80403. The water quality results for each of the distinct sample areas (ponds, floodplain [wetlands], and Dolores River), the sediment results, the soil results, and the QA/QC sample results are discussed below.

For comparative purposes, the surface water and pore water sample concentrations are discussed relative to state WQS. The Colorado WQS for Dolores River Stream Segment 3 (5 CCR 1002-34) apply to the Dolores River near the site. Table 9 shows the WQS for the contaminants of concern and iron. Several of the standards are hardness-based. For simplicity, the WQS used in the comparisons below were calculated at hardness of 247 milligrams per liter (mg/L), the same value calculated by the Colorado Department of Public Health and Environment Water Quality Control Division (CDPHE WQCD) and presented in a Water Quality Assessment (Colorado Department of Public Health and Environment [CDPHE] 2008).

Pond water sample results were also compared to the water quality-based effluent limits (WQBELs) that were calculated by the CDPHE WQCD and reported in the Water Quality Assessment (CDPHE 2008). The WQBELs were developed by performing a mass balance using the Dolores River WQS calculated at a hardness of 247 mg/L, low flow in the Dolores River, the St. Louis Ponds design flow, and an average background concentration in the Dolores River. This comparison is for informational purposes only because permit limitations have not been set for use at the site, and the values shown may be superseded by antidegradation-based average concentrations, non-impact limit concentrations, or other values identified by the WQCD.

4.1 POND WATER SAMPLE RESULTS

Mine discharge water was collected from the flume located downstream of the former lime addition facility (SLSWDR3, referred to in this report as "mine discharge") and from the pipe that discharges into Pond 15 (SLSWPP). Pond discharge samples were collected from the outfall from each pond (SLSWP##, where ## is the two-digit pond number from which the effluent was sampled) and from the flume located between Pond 5 and the pond system outfall to the Dolores River (SLSWDR6, referred to in this report as "pond system outfall"). Because the adit discharge is piped directly to Pond 15, and Pond 18 no longer receives the adit discharge, the following discussion focuses on the series of ponds through which the mine water flows prior to discharge to the Dolores River: Ponds 15, 14, 12, 11, 9, 8, 7, 6, and 5 (pond system outfall). Pond 10 is not in the series of ponds that receive the mine discharge water; therefore, the sample results for Pond 10 are discussed separately. Tables 3 and 4 present the dissolved and total metal concentrations. Photos 1 through 18 in the Photolog (Appendix A) show the pond system sample locations from upstream to downstream.

The dissolved cadmium concentration in the mine discharge was 16.3 micrograms per liter (pg/L), and the dissolved cadmium concentration at the pond system outfall was 11.0 pg/L. The total cadmium concentration in the mine discharge was 19.0 pg/L, and the total cadmium concentration at the pond system outfall was 12.3 pg/L. The largest decrease in cadmium concentration occurred in Pond 15 where the total cadmium concentration decreased from 18.1 pg/L to 14.9 pg/L.

The dissolved copper concentration in the mine discharge was 9.17 pg/L, and dissolved copper was not detected above the method detection limit of 2.50 pg/L at the pond system outfall. The total copper concentration in the mine discharge was 193 pg/L, and the total copper concentration at the pond system outfall was 22.8 pg/L. The largest decrease in copper concentration occurred in Pond 15 where the total copper concentration decreased from 196 pg/L to 69.8 pg/L.

Dissolved lead was not detected in the mine discharge or in any of the pond samples at or above the method detection limit of 0.500 pg/L. The total lead concentration in the mine discharge was 20.6 pg/L, and the total lead concentration at the pond system outfall was 2.99 pg/L. The largest decrease in total lead concentration occurred in Pond 15 where the lead concentration decreased from 21.9 pg/L to 7.54 pg/L.

The dissolved manganese concentration in the mine discharge was 1,760 pg/L, and the dissolved manganese concentration at the pond system outfall was 1,620 pg/L. The total manganese concentration in the mine discharge was 1,770 pg/L, and the total manganese concentration at the pond system outfall was 1,600 pg/L. The manganese concentrations in the pond system varied slightly from pond to pond with a maximum total manganese concentration of 1,810 pg/L (effluent from Pond 9) and a minimum total manganese concentration of 1,600 pg/L (effluent from Ponds 7 and 5).

The dissolved zinc concentration in the mine discharge was 3,580 pg/L, and the dissolved zinc concentration at the pond system outfall was 2,490 pg/L. The total zinc concentration in the mine discharge was 3,720 pg/L, and the total zinc concentration at the pond system outfall was 2,470 pg/L. The largest decrease in zinc concentration occurred in Pond 15 where the total zinc concentration decreased from 3,810 pg/L to 3,070 pg/L.

Table 10 presents the percent decrease in the dissolved metals concentration between the mine discharge and the effluent from each of the ponds. Negative values indicate an increase in concentration. Because flow rates between ponds were not measured, the load reduction between ponds could not be calculated directly.

The most dramatic decreases in aluminum, cadmium, chromium, copper, iron, and zinc concentrations were observed within Pond 15, the first pond to receive the adit discharge in the current pond configuration since Pond 18 was drained in October 2010. Concentrations of dissolved copper and iron dropped from measurable concentrations to non-detected concentrations in Pond 15. Zinc and cadmium concentrations decreased most dramatically in Pond 15 but continued to decrease in subsequent ponds. Little attenuation of the other metals was seen in downstream ponds. Between the adit discharge flume (SLSWDR3) and the pond system outfall flume (SLSWDR6), the concentrations of both cadmium and zinc decreased by approximately 30 percent. Less than 10 percent of the manganese was attenuated.

The concentrations of the major cations (calcium, magnesium, potassium, and sodium) and hardness were consistent through the treatment pond series, and it is evident that if residual lime is present in the pond sludge from previous lime treatment, it is not adding these elements to the dissolved fraction. Magnesium, potassium, sodium, total alkalinity, and, to a lesser extent, calcium concentrations increased in Ponds 6 and 5 relative to the upper ponds, perhaps due to the inflow of geothermal waters or groundwater.

Pond 10 is not in the treatment system series, but it does conttibute a small amount of water to Pond 9. Water enters the pond via precipitation, runoff, and possibly via groundwater flow. Concentrations of barium, cadmium, total iron, sodium, and zinc were lower in Pond 10 than those measured in the other pond samples. Concentrations of calcium, chromium, magnesium, manganese, potassium, selenium, hardness, and total alkalinity were higher in Pond 10 than in the other ponds, and Pond 10 may be a source of these contaminants to lower ponds.

Field parameters (Table 2) followed general trends in the pond system. The pH increased between the mine discharge and Pond 15, continued to increase into Ponds 14 and 12, and remained stable down to Pond 9. Downstream of Pond 9, pH began to decrease gradually to a minimum value in Pond 6. Uncertainty in the reliability of field pH measurements may be introduced by the low temperatures during field work. Due to the uncertainty, pH measurements were repeated using an In-Situ Troll 9500 meter. While the values for pH were different than those measured using the original equipment, the relative values in the different ponds were similar. Conductivity showed less of a ttend than pH as water flowed through the ponds. Conductivity was highest in Ponds 10, 6, and 5, which all receive water from sources other than the adit water collection system, including geothermal water and possibly groundwater.

Dissolved metal concentrations in the adit discharge and pond system outfall were compared to concentrations from the late 1990s and early 2000s (Tables 11 and 12). The November 2010 concentrations were similar to previous fall sampling events.

As a point of comparison, the metal concentrations in the ponds were compared to WQS (Table 13). All of the samples collected from the series of ponds that receive mine discharge water (Ponds 15, 14, 12, 11, 9, 8, 7, 6, and the pond system outfall) exceeded chronic and acute WQS for dissolved cadmium (3.74 pg/L and 0.84 pg/L, respectively), dissolved zinc (310 pg/L and 269 pg/L, respectively) and the chronic standard for total iron (1,000 pg/L). At the pond system outfall (sample SLSWDR6), the dissolved zinc concentration (2,490 pg/L) exceeded the acute WQS by a factor of 8 and the dissolved cadmium concentration (11.0 pg/L) exceeded the acute WQS by a factor of 3.

The WQBELs provide an indication of the concentrations in the pond system outfall that could cause an exceedance of WQS in the Dolores River during low flow conditions. Metal concentrations that exceed the WQBELs, and thus would be expected to cause WQS to be exceeded in the Dolores River during low flow, are shown in italics on Table 13. The dissolved cadmium and zinc concentrations in all of the treatment ponds exceeded the WQBELs. At the pond system outfall, the dissolved cadmium concentration of 11.0 pg/L was 4.8 times the WQBEL (2.3 pg/L), and the dissolved zinc concentration of 2,490 pg/L was 3.4 times the WQBEL (729 pg/L). Iron concentrations in Pond 15 through Pond 9 exceeded die WQBEL, but the concentrations were lower in the subsequent ponds.

4.2 FLOODPLAIN WATER SAMPLE RESULTS

Co-located surface water and pore water samples were collected in the wetlands between the ponds and the Dolores River. Samples SLSW01, SLSW02, SLSW03, and SLSW04 were collected within a flowing river side channel and the co-located pore water samples (SLSWPO01, SLPO02, SLPO03, and SLPO04) were located from 8 to 12.5 centimeters below the river side channel, depending on location (see Table 1). Sample SLSW04 was collected immediately upstream of the side channel outfall to the Dolores River. Sample SLSW05 and the co-located pore water sample (SLPO05) were collected in standing water at an apparent seep at the base of the southwest comer of Pond 15 in a second, unconnected wetland that does not contain channelized water. Four of the sample locations were at or near the base of the west berms of the ponds. Samples SLSW02, SLSW03, and the co-located pore water samples were collected immediately west of Pond 18. Samples SLSW03 and SLSW04 and the co-located pore water samples were collected at the base of Pond 15. Photos 19 through 24 in Appendix A show the floodplain sample locations from upstream to downstream.

The analytical results from samples collected in the river side channel at the base of the pond berms may provide an indication of whether and where the ponds are leaking to the wetlands and the Dolores River (Tables 3 and 4). The highest dissolved cadmium and zinc concentrations in the floodplain were measured in the surface water and pore water samples collected at the base of the berm at the southwest comer of Pond 15. The dissolved cadmium concentrations in the surface water (SLSW05) and pore water (SLPO05) at this location were 4.76 pg/L and 2.87 pg/L, respectively, and the dissolved zinc concentrations were 918 pg/L and 580 pg/L, respectively. The location relative to Pond 15 and the elevated metal concentrations relative to the other river side channel samples indicate that the sampled water was likely seeping from Pond 15. Metal concentrations in the pore water and surface water collected at this location were lower than concentrations measured in Pond 15, providing an indication that there is some dilution or atrenuation of metals as the water flows toward the river.

The dissolved lead and zinc concentrations in pore water sample SLPO03, located near the base of the southwest comer of Pond 18, and the dissolved iron and manganese concentrations in pore water sample SLPO02, located near the northwest comer of Pond 18, were elevated compared to the other wetland locations upstream of Pond 15. The co-located surface water samples did not contain appreciable concentrations of these metals. The elevated dissolved metals concentrations may be caused by the adit discharge and/or Pond 18. The highest total aluminum, copper, iron, lead, and manganese concentrations measured in the floodplain samples were detected in sample SLPO02, the pore water sample collected near the north end of Pond 18 where it appeared water may have seeped from Pond 18 when the pond was in service.

The concentrations of other analytes that are expected to be higher in mine discharge and pond water than in the Dolores River, and associated wetland water can also provide an indication of whether and where the ponds are leaking. Calcium, magnesium, and sodium concentrations and hardness in samples located west of Pond 15 (surface water sample SLSW05 and pore water samples SLPO04 and SLPO05) were elevated compared to the upgradient floodplain samples, indicating the influence of the mine discharge and pond system. Dissolved calcium concentrations ranged from 224,000 pg/L to 238,000 pg/L in samples SLSW05, SLPO05, and SLPO04 and ranged from 57,900 pg/L to 73,600 pg/L in the remaining floodplain samples. Dissolved magnesium concentrations ranged from 20,100 pg/L to 22,200 pg/L in samples SLSW05, SLPO05, and SLPO04 and ranged from 7,110 pg/L to 7,980 pg/L in the remaining floodplain samples. Dissolved sodium concentrations ranged from 9,800 pg/L to 10,800 pg/L in samples SLSW05, SLPO05, and SLPO04 and ranged from 2,250 pg/L to 2,860 pg/L in the remaining floodplain samples. Hardness ranged from 643 mg/L to 686 mg/L in samples SLSW05, SLPO05, and SLPO04 and ranged from 174 mg/L to 214 mg/L in the remaining floodplain samples. The surface water sample co-located with SLPO04 did not contain elevated calcium, magnesium, and sodium concentrations, likely because the water is diluted by the side channel. Elevated calcium, magnesium, sodium, and hardness concentrations were not observed in the samples collected in the wetland immediately west of Pond 18; however, Pond 18 had been drained of water since October. Previous inspections had noted evidence of iron stained seepage at the base of Pond 18. It is unknown if similar concentrations would have been observed in samples SLPO03, SLPO02, or the co-located surface water samples if Pond 18 were still operational.

As a point of comparison, the dissolved metal concentration in each sample was compared to the WQS (Table 13). The pore water (SLSWPO05) and co-located surface water (SLSWSW05) samples collected at the botrom of the berm at the southwest comer of Pond 15 exceeded the acute and chronic zinc WQS (310 pg/L and 269 pg/L, respectively) and the chronic cadmium WQS (0.84 pg/L) but not the iron WQS (1,000 pg/L). The pore water samples at the other wetland locations, all collected from within or beneath the side charmel) exceeded the iron WQS but not the cadmium or zinc WQS. Sample SLPO02 exceeded the chronic manganese WQS (2,230 pg/L), and sample SLPO03 exceeded the chronic lead WQS (6.6 pg/L). The remaining pore and co-located surface water samples did not exceed WQS.

4.3 DOLORES RIVER WATER SAMPLE RESULTS

Samples were collected in the Dolores River upstream of the site (SLSWDRBG), 110 feet downstream of the pond system outfall (SLDRMZ1), 230 feet downstream of the pond system outfall (SLDRMZ2), and approximately 50 feet downstream of the Highway 143 bridge (SLSWDR7b). Surface water samples in the mixing zone location 110 feet downstream of the pond system outfall (SLDRMZ1) were collected from ¼, ½, and ¾ of the distance across the river. Photos 25 through 30 in Appendix A show the Dolores River sample locations from upstream to downstream.

The background sample collected upstream of the site had relatively low hardness, 133 mg/L, compared with the downstream locations where hardness was as great as 248 mg/L. This is to be expected as higher hardness water from the mine, pond system outfall, groundwater, and geothermal water enters the system within the reach.

The cadmium concentration increased from non-detected at 0.100 pg/L at the background location to 0.647 pg/L downstream of the Highway 143 bridge with a maximum of 1.87 pg/L on the east side of the river approximately 110 feet downstream of the pond system outfall. Approximately 230 feet downstream of the pond system outfall and immediately upstream of the inflow of water from the lower ponds (Ponds 1 through 4), the cadmium concentration was 0.513 pg/L.

The zinc concentration increased from non-detected at 10.0 pg/L at the background location to 143 pg/L downstream of the Highway 145 bridge with a maximum of 390 pg/L on the east side of the river approximately 110 feet downstream of the pond system outfall. Approximately 230 feet downstream of the pond system outfall and immediately upstream of the inflow of water from the lower ponds, the zinc concentration was 173 pg/L. The flow conditions were not at the expected seasonal low when these samples were collected.

The highest Dolores River metal concentrations were observed on the east side of the river approximately 110 feet downstream of the pond system outfall, showing that water from the pond system outfall is not completely mixed at this location resulting in concentrations above WQS.

Total metals concentrations were generally similar to dissolved concentrations in the Dolores River.

For comparison purposes, the Dolores River sample results were compared to WQS. The sample collected in the Dolores River upsfream of the site (SLSWBG) meets WQS for the measured analytes (Table 13). The sample collected closest to the east side of the Dolores River approximately 110 feet downstream of the pond system outfall (SLSWMZlc) contained a dissolved cadmium concentration of 1.87 pg/L, which exceeds the chronic cadmium standard of 0.84 pg/L. The same sample contained a dissolved zinc concenfration of 390 pg/L, which exceeds the acute and chronic WQS of 310 pg/L and 269 pg/L, respectively. The downstream mixing zone sample (SLSWMZ2) and the sample collected below the Highway 145 bridge (SLSWDR7b) did not exceed WQS for the measured analytes.

As shown in Section 3.3, the flow from the pond system outfall (671 gpm) during the November 2010 sampling event was approximately 10 percent or less of the flow in the Dolores River at the Highway 145 bridge (7,140 gpm). Flow data from USGS Station 09165000, Dolores River Below Rico, Colorado, (CDPHE 2008) indicates that during low flow conditions, the flow from the pond system outfall may be as high as 25 percent of the downstream flow in the Dolores River, resulting in less dilution of contaminants present in the pond system outfall. The WQBELs identify pond system outfall concentrations that may cause exceedances of WQS in the Dolores River during low flow conditions (CDPHE 2008). Metal concentrations that exceed the WQBELs and thus would be expected to cause WQS to be exceeded in the Dolores River during low flow are shown in italics on Table 13. Cadmium and zinc concentrations in the pond system outfall exceeded the WQBEL during November 2010. The reach of river that would be impacted during low-flow periods is unknown.

4.4 SEDIMENT SAMPLE RESULTS

Sediment samples were collected from the southeast comer of Pond 18 (SLSE18-06), Pond 15 immediately north of the inflow pipe (SLSEPP-06), at the Pond 15 (SLSE15) and Pond 10 (SLSE10) water sample locations, in the botrom of Pond 13 (SLSO13), and in Ponds 2 (SLSE02), 4 (SLSE04), and 5 (SLSE05). Until fall 2010, the mine discharge water flowed into Pond 18, through Ponds 15, 14, 12, 11, 9, 8, 7, 6, and 5, and was discharged to the Dolores River from Pond 5. During fall 2010 and prior to the sampling described here, water was diverted around Pond 18 so the mine discharge water flowed directly into Pond 15. Ponds 13 (empty at the time of sampling) and 10 are parallel to this series of ponds but did not receive the mine discharge water at the time of sampling. Ponds 2 and 4 are located downgradient of the point of discharge from the series of ponds that receive the mine discharge water. Sediment sample results are presented on Table 5.

Arsenic was detected in the pond sediment samples in concentrations ranging from 3.32 milligrams per kilogram (mg/kg) in Pond 5 to 156 mg/kg in Pond 4. Arsenic concentrations were the highest in Ponds 2 and 4, located downstream of the pond system outfall to the Dolores River, and in Pond 10 that was not part of the series of ponds that receive the mine discharge during fall 2010.

Cadmium was detected in the pond sediment samples in concentrations ranging from 3.16 mg/kg in Pond 5 to 471 mg/kg in Pond 15. Cadmium concentrations were highest in samples collected from Pond 15 (359 mg/kg to 471 mg/kg), the first pond that receives the adit discharge.

Copper was detected in the pond sediment samples in concentrations ranging from 42.7 mg/kg in Pond 2 to 3,400 mg/kg in Pond 18. Copper concentrations were highest in Ponds 15 and 18 (2,990 mg/kg to 3,400 mg/kg), the first ponds that receive the adit discharge, and in Pond 13 (2,790 mg/kg).

Iron was detected in the pond sediment samples in concentrations ranging from 2,210 mg/kg in Pond 2 to 382,000 mg/kg in Pond 13. Iron concentrations were highest in Ponds 13, 15, and 18 (ranging from 152,000 mg/kg to 382,000 mg/kg), and the lowest in Pond 2 (2,210 mg/kg).

Lead was detected in the pond sediment samples in concentrations ranging from 18.5 mg/kg in Pond 5 to 924 mg/kg in Pond 13. Lead concentrations were an order of magnitude higher in sediments from Ponds 4, 10, 13, 15, and 18 (ranging from 314 mg/kg to 924 mg/kg) than in sediments from Ponds 2 and 5 (ranging from 18.5 mg/kg to 23.2 mg/kg).

Manganese was detected in the pond sediment samples in concentrations ranging from 433 mg/kg in Pond 5 to 98,700 mg/kg in Pond 15. Manganese concentrations were highest in sediments from Pond 15 (ranging from 82,400 mg/kg to 98,700 mg/kg), lower in Ponds 18 and 10 (6,390 mg/kg and 21,700 mg/kg, respectively), and lowest in Ponds 2, 4, 5, and 13 (ranging from 433 mg/kg to 3,120 mg/kg).

Selenium concentrations in the pond sediment samples ranged from non-detected at 0.500 mg/kg in Pond 5 and non-detected at 2.50 mg/kg in Pond 4 to 40.2 mg/kg in Pond 10. Pond 10 is not in the series of ponds that receive the mine discharge.

Zinc concentrations in the pond sediment samples ranged from 1,330 mg/kg in Pond 5 to 91,700 mg/kg in Pond 15. Zinc concentrations were highest in Ponds 15 and 18 (ranging from 28,000 mg/kg to 91,700 mg/kg), the first ponds that receive the adit discharge.

As a point of comparison, the pond sediment sample metals concentrations were compared to the toxic effects level values developed by Macdonald and others (MacDonald et. al 2000) (Table 5). Concentrations less than the Threshold Effect Concentrations (TEC) are considered protective of fresh water aquatic organisms, and concentrations above the Probable Effect Concentrations

(PEC) are considered likely to harm fresh water aquatic organisms. Concentrations of cadmium, copper, lead, and zinc in most of the pond sediment samples were greater than the PEC and TEC. Concentrations of arsenic and nickel were greater than the PEC and TEC in some samples. The pond sediment concentrations do not reflect sediment quality present in the Dolores River at this time.

4.5 SOIL SAMPLE RESULTS

Soil sampling was limited to areas where suspicious surface soils were previously identified and was not intended to be comprehensive evaluation of soils at the site. Sample SLSO01 was collected north of the Pond 18 north berm in an area that previously contained red-stained gravel and soil. The material present at the time of sampling appeared to be recently placed fill, though the presence of snow made identification of the material difficuh. Sample SLSO02 was collected in an area containing reddish gravel and soil on the berm between Ponds 15, 14, and 13.

Sample SLSO01 contained 19.3 mg/kg arsenic, 26.8 mg/kg barium, 5.09 mg/kg cadmium, 555 mg/kg copper, 171,000 mg/kg iron, 2,210 mg/kg lead, 259 mg/kg manganese, 2.75 mg/kg selenium, 15.3 mg/kg silver, and 922 mg/kg zinc. Sample SLSO02 contained 11.2 mg/kg arsenic, 20.5 mg/kg barium, 1.88 mg/kg cadmium, 281 mg/kg copper, 81,000 mg/kg iron, 1,470 mg/kg lead, 537 mg/kg manganese, 2.43 mg/kg selenium, 7.06 mg/kg silver, and 355 mg/kg zinc.

Soil metal concentrations were compared with Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (EPA 2010). Arsenic, barium, cadmium, copper, iron, lead, manganese, selenium, silver, and zinc generally exceeded the soil screening levels for the protection of groundwater, and the arsenic and lead concentrations also exceeded the industrial soil screening level (1.6 mg/kg and 800 mg/kg, respectively) in both of the soil samples.

4.6 QUALITY ASSURANCE/QUALITY CONTROL SAMPLE RESULTS

The field blank water sample did not contain detectable concentrations of any of the measured analytes (Tables 6 and 7).

The duplicate samples were compared by calculating the relative percent difference (RPD) as shown on Tables 6 through 8. In general, the duplicate results were very close and the RPD was low except for samples with concentrations very close to the detection limit. RPDs that exceed the acceptable values of 20 percent for water and 35 percent for soil and sediment are shown in bold on Tables 6 through 8.

5.0 RECOMMENDATIONS

Flow and water quality from the adit discharge and treatment pond effluent should be measured on a regular basis. Additional and more comprehensive pond sediment sampling may be needed to assess concentrations and to determine potential disposition of materials stored in the ponds.

6.0 LIST OF REFERENCES

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URS Operating Services, Inc. (UOS). 2010. Letter Report for Rico-Argentine St. Louis Tunnel Site, Rico, Delores County, Colorado. From Bryan Williams, URS Operating Services, Inc. to Mr. Steven Way, On-Scene Coordinator, Environmental Protection Agency. August 18, 2010.

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Legend

- Sample Locations
- Pond Outfall
- Treatment Ponds

N

Projection System:
Universal Transverse
Mercator Zone 13 North
North American Datum 1983

Feet
0 250 500

URS
OPERATING SERVICES

Sources: Bing Maps
URS/UOS data acquisition 2010

TDD Title: **Rico Argentine St. Louis Tunnel**
TDD County: DOLORES TDD: 1005-01
TDD State: CO Date: 03/2011
Figure No. 1 Figure Title: Sample Location Map

TABLE 1
Sample Locations

Sample ID	Description	Latitude /Longitude
SLSE02	Sediment from Pond 2.	37.699799597 -108.030146816
SLSE04	Sediment from Pond 4.	37.70066744 -108.030169493
SLSE05	Sediment from Pond 5.	37.701238109 -108.030190520
SLSE10	Same location as SLSW10.	37.703835495 -108.030306969
SLSE15-06	Same location as SLSW15. 0-6" depth.	37.705397624 -108.031286714
SLSE15D	Duplicate of Sample SLSE15-06.	
SLSE18-06	Sediment from Pond 18. 0-6" depth.	37.706586827 -108.031433543
SLSEPP-06	Sediment from pond 15 north of SLSWPP pipe. 0-6" depth.	37.706256018 -108.031478830
SLSO01	Loose soil north of Pond 18. 0 to 8" depth.	37.707947542 108.031783987
SLSO02	Berm between Ponds 13, 14, and 15. 0 to 6" depth.	37.705510438 -108.031063683
SLSO13	Soil/sediment from bottom of Pond 13.	37.705126751 -108.030580637
SLSW01 SLPO01	Stream in wetland, north of ponds. Pore water collected at 10 centimeters below ground surface.	37.708323283 -108.032170854
SLSW02 SLPO02	Stream in wetland, west of north end of Pond 18. Pore water collected at 8.2 centimeters below ground surface.	37.707432954 -108.032298472
SLSW03 SLPO03	Stream in wetland, west of Pond 18 Pore water collected at 9.7 centimeters below ground surface.	37.707011029 -108.032237415
SLSW04 SLPO04	Stream in wetland approximately 30 feet upstream of outfall to Dolores River. Pore water collected at 10 centimeters below ground surface.	37.706540932 -108.032180929
SLSW05 SLPO05	Seep at base of riprap berm west of the south end of Pond 15. Pore water collected at 12.5 centimeters below ground surface.	37.705515494 -108.031899010
SLSWDRBG	Dolores River upstream of site and downstream from Horse Creek confluence.	37.711713333 -108.032117244
SLSWDR3	Sample collected in the flume located downstream of the lime silo and upstream of the underground piping system that carries the water to Pond 15.	37.70083333* -108.0305556
SLSWDR6	Sample collected in the flume downstream of Pond 5 and upstream of the pond system outfall to the Dolores River.	37.700861618 -108.030238113

TABLE 1
Sample Locations

Sample ID	Description	Latitude /Longitude
SLSWDR7B	Dolores River approximately 50 feet downstream of Highway 145 bridge north of Rico.	37.697572797 -108.031173967
SLSWMZ1A	Dolores River approximately 110 feet downstream of pond system outfall. Conductivity measurements showed incomplete mixing of pond system outfall with Dolores River at this location, so three points were sampled across the river. MZ1A was collected approximately ¾ of the distance across the river from the east bank.	37.700439964 -108.030711693
SLSWMZ1B	Dolores River downstream of pond system outfall. MZ1B was collected approximately ½ of the distance across the river from the east bank.	
SLSWMZ1C	Dolores River downstream of pond system outfall. MZ1A was collected approximately ¼ of the distance across the river from the east bank.	
SLSWMZ2	Dolores River approximately 230 feet downstream of the pond system outfall.	37.700100013 -108.030697823
SLSWP06	Sample collected in the spillway from Pond 6 to Pond 5.	37.701312025 -108.030116317
SLSWP07A	Sample collected from the pipe from Pond 7 to Pond 6.	37.701759752 -108.029954059
SLSWP07B	Sample collected in the spillway from Pond 7 to Pond 6. The spillway is east of the P07A sample location.	37.701852365 -108.029777030
SLSWP08	Sample collected in the spillway from Pond 8 to Pond 7.	37.702477710 -108.030432277
SLSWP09	Sample collected in the spillway from Pond 9 to Pond 8.	37.703012903 -108.030426262
SLSWP10	Sample collected in the small channel between Pond 10 and Pond 9. Water flows from Pond 10 to Pond 9.	37.703835495 -108.030306969
SLSWP11	Sample collected from the pipe that carries water from Pond 11 to Pond 9.	37.703824278 -108.030534392
SLSWP12	Sample collected in the spillway from Pond 12 to Pond 11.	37.704321749 -108.030929878
SLSWP14	Sample collected in the spillway from Pond 14 to Pond 12.	37.704953549 -108.031209164
SLSWP15	Sample collected in ponded water below two pipes that carry water from Pond 15 to Pond 14.	37.705397624 -108.031286714
SLSWPP	Sample collected from the pipe that carries water from the adit discharge channel to Pond 15.	37.706256018 -108.031478830

* GPS location for Outfall 001 from Atlantic Richfield Permit Application (Atlantic Richfield Company 2010)

TABLE 2
Field Parameters

Sample Location	pH* (standard units)	Conductivity (mmho/cm)	Temperature (°C)	Total Dissolved Solids (parts per billion)	Dissolved Oxygen (percent)
Dolores River Surface Water (upstream to downstream)					
SLSWBG	8.18	305	1.7	--	11.1
SLSWMZ1A	7.81	363	2.4	261	--
SLSWMZ1B	7.78	420	2.4	302	--
SLSWMZ1C	7.67	571	2.6	408	--
SLSWMZ2	7.75	446	2.7	319	--
SLSWDR7B	7.86	443	1.6	315	--
Co-located surface water and pore water samples (upstream to downstream)					
SLSW01 SLPO01	7.48*	435	6.6	--	7.57
SLSW02 SLPO02	7.86*	412	5.6	--	9.65
SLSW03 SLPO03	7.96*	412	5.2	--	9.78
SLSW04 SLPO04	7.66*	448	3.5	--	9.87
SLSW05 SLPO05	--	--	--	--	--
Pond System Samples (upstream to downstream)					
SLSWDR3	6.85	1,122	13.4	794	--
SLSWPP	7.19 / 6.88*	1,029	13.9	731	--
SLSWP15	8.05 / 7.57*	1,210	9.2	860	--
SLSWP14	8.2 / 7.76*	1,150	7.2	818	--
SLSWP12	8.58 / 7.91*	1,184	8.5	850	--
SLSWP11	8.6 / 8.0*	1,250	2.5	888	--
SLSWP10	7.65	1,410	2.8	1,000	--
SLSWP09	8.55 / 7.97*	1,100	3.2	780	--
SLSWP08	8.26 / 7.69*	1,278	2.5	907	--
SLSWP07A	8.19	1,184	2.2	840	--
SLSWP07B	8.18	1,150	1.8	812	--
SLSWP06	7.74	1,330	2.9	945	--
SLSWDR6	8.15	1,335	2.5	950	--

* Indicates pH values that were collected using the ESAT In-Situ Troll 9500 instrument.

TABLE 3
Surface Water and Pore Water Dissolved Metals Concentrations

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Hardness (mg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (µg/L)	Total Alkalinity (mg $CaCO_3$/L)	Zinc (µg/L)
Pond System Samples (upstream to downstream)																				
SLSWDR3	110	2.50 U	17.6	16.3 D	241,000	5.10 D	0.599 JD	9.17 D	687	2,830	0.500 U	20,400	1,760 D	2.50 U	1,750	2.50 U	0.500 U	11,100	105	3,580
SLSWPP	57.3	2.50 U	17.5	16.4 D	244,000	4.01 JD	0.500 U	2.50 U	694	2,140	0.500 U	20,700	1,780 D	2.50 U	1,750	2.50 U	0.500 U	11,200	106	3,530
SLSWP15	33.7 J	2.50 U	16.7	13.2 D	246,000	3.72 JD	0.500 U	2.50 U	700	100 U	0.500 U	20,600	1,790 D	2.50 U	1,770	2.50 U	0.500 U	11,400	101	2,820
SLSWP14	23.1 J	2.50 U	16.9	12.1 D	244,000	3.08 JD	0.500 U	2.50 U	695	100 U	0.500 U	20,700	1,740 D	2.50 U	1,760	2.50 U	0.500 U	11,400	100	2,750
SLSWP12	28.9 J	2.50 U	16.7	12.3 D	244,000	3.39 JD	0.500 U	2.50 U	694	100 U	0.500 U	20,700	1,710 D	2.50 U	1,780	2.50 U	0.500 U	11,200	99.9	2,680
SLSWP11	29.1 J	2.50 U	16.4	11.8 D	243,000	2.55 JD	0.500 U	2.50 U	692	100 U	0.500 U	20,600	1,730 D	2.50 U	1,770	2.50 U	0.500 U	11,200	7.08	2,580
SLSWP10	41.7 J	2.50 U	12.0	0.500 U	271,000	5.04 D	0.500 U	2.50 U	804	362	0.500 U	31,100	2,230 D	2.50 U	2,430	5.60 D	0.500 U	10,400	134	261
SLSWP09	32.0 J	2.50 U	16.0	11.4 D	244,000	3.02 JD	0.500 U	2.50 U	695	100 U	0.500 U	20,800	1,680 D	2.50 U	1,780	2.50 U	0.500 U	11,200	101	2,520
SLSWP08	35.4 J	2.50 U	16.1	12.1 D	246,000	3.74 JD	0.500 U	2.50 U	702	100 U	0.500 U	21,300	1,690 D	2.50 U	1,870	2.50 U	0.500 U	11,400	106	2,550
SLSWP07a	25.4 J	2.50 U	15.7	11.3 D	248,000	3.90 JD	0.500 U	2.50 U	708	100 U	0.500 U	21,600	1,690 D	2.50 U	1,940	2.50 U	0.500 U	11,600	109	2,520
SLSWP07b	30.4 J	2.50 U	16.2	11.3 D	248,000	3.93 JD	0.500 U	2.50 U	708	100 U	0.500 U	21,500	1,680 D	2.50 U	1,920	2.50 U	0.500 U	11,500	111	2,550
SLSWP06	26.4 J	2.50 U	16.5	11.5 D	255,000	4.39 JD	0.500 U	2.50 U	731	100 U	0.500 U	23,100	1,710 D	2.50 U	2,330	2.50 U	0.500 U	13,100	127	2,460
SLSWDR6	37.4 J	2.50 U	16.6	11.0 D	254,000	5.68 D	0.500 U	2.50 U	730	100 U	0.500 U	23,100	1,620 D	2.50 U	2,370	2.50 U	0.500 U	13,200	130	2,490
Co-located surface water and pore water samples (upstream to downstream)																				
SLSW01	20.0 U	2.50 U	56.2	0.500 U	67,200	6.19 D	0.500 U	2.50 U	201	100 U	0.500 U	7,980	5.48 D	2.50 U	793 J	2.50 U	0.500 U	2,360	131	10.0 U
SLPO01	20.6 J	2.50 U	51.6	0.500 U	68,100	7.48 D	0.500 U	2.50 U	203	100 U	0.500 U	7,920	30.9 D	2.50 U	825 J	2.50 U	0.500 U	2,340	134	17.1 J
SLSW02	20.0 U	2.50 U	58.2	0.500 U	61,800	4.61 JD	0.500 U	2.50 U	185	100 U	0.500 U	7,500	2.03 JD	2.50 U	758 J	2.50 U	0.500 U	2,370	122	10.1 J
SLPO02	23.5 J	2.50 U	47.9	0.500 U	73,600	6.22 D	0.616 JD	2.50 U	214	5,310	0.529 JD	7,320	2,480 D	2.50 U	1,200	2.50 U	0.500 U	2,860	128	10.0 U
SLSW03	20.0 U	2.50 U	54.2	0.500 U	57,900	5.33 D	0.500 U	2.50 U	174	100 U	0.500 U	7,110	1.00 U	2.50 U	705 J	2.50 U	0.500 U	2,250	122	10.0 U
SLPO03	20.0 U	2.50 U	45.0	0.500 U	61,900	5.55 D	2.66 D	2.50 U	186	100 U	5.28 D	7,540	6.59 D	2.50 U	776 J	2.50 U	0.500 U	2,350	123	131
SLSW04	20.0 U	2.50 U	55.9	0.500 U	67,200	4.83 JD	0.500 U	2.50 U	201	100 U	0.500 U	7,980	45.6 D	2.50 U	783 J	2.50 U	0.500 U	2,620	122	10.0 U
SLPO04	26.8 J	3.51 JD	21.4	0.500 U	224,000	6.33 D	0.500 U	2.50 U	643	2,360	0.500 U	20,100	1,050 D	2.50 U	2,030	2.50 U	0.500 U	9,800	112	10.9 J
SLSW05	22.7 J	2.50 U	13.3	4.76 D	231,000	4.89 JD	0.500 U	2.50 U	665	100 U	0.500 U	21,500	1.00 U	2.50 U	1,590	2.88 JD	0.500 U	10,500	92.8	918
SLPO05	24.1 J	2.50 U	17.5	2.87 D	238,000	3.83 JD	0.500 U	2.50 U	686	116 J	0.500 U	22,200	176 D	2.50 U	1,700	2.50 U	0.500 U	10,800	95.7	580
Dolores River Surface Water (upstream to downstream)																				
SLDRBG	20.0 U	0.500 U	67.2	0.100 U	42,500	2.95	0.100 U	0.500 U	133	100 U	0.100 U	6,430	11.3	0.500 U	651 J	0.892 J	0.116 J	2,730	94.7	10.0 U
SLDRMZ1a	20.0 U	2.50 U	61.8	0.500 U	54,500	5.70 D	0.500 U	2.50 U	167	100 U	0.500 U	7,570	126 D	2.50 U	858 J	2.50 U	0.500 U	3,370	103	30.5
SLDRMZ1b	24.6 J	2.50 U	59.8	0.736 JD	65,800	5.17 D	0.500 U	2.50 U	199	100 U	0.500 U	8,470	224 D	2.50 U	928 J	2.50 U	0.500 U	3,970	105	176
SLDRMZ1c	31.3 J	2.50 U	55.3	1.87 D	83,000	5.94 D	0.500 U	2.50 U	248	100 U	0.500 U	9,830	361 D	2.50 U	1,050	2.50 U	0.500 U	4,790	109	390
SLDRMZ2	20.9 J	2.50 U	59.7	0.513 JD	66,000	5.51 D	0.500 U	2.50 U	200	100 U	0.500 U	8,500	224 D	37.4 D	955 J	2.50 U	0.500 U	3,950	106	173
SLSWDR7b	24.2 J	2.50 U	60.4	0.647 JD	67,500	4.91 JD	0.500 U	2.50 U	206	100 U	0.500 U	8,960	205 D	2.50 U	1,130	2.50 U	0.500 U	4,390	110	143

U Analyte not detected above the method detection limit.
J Data is estimated. Value is greater than or equal to the method detection limit but less than the practical quantitation limit.
D Sample was diluted prior to analysis.
µg/L micrograms per liter
mg/L milligrams per liter

TABLE 4
Surface Water and Pore Water Total Metals Concentrations

STATION_ID	SAMPDATE	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (µg/L)	Zinc (µg/L)
Pond System Samples (upstream to downstream)																			
SLSWDR3	11/16/2010	1,170	2.50 U	16.2	19.0 D	237,000	2.50 U	0.500 U	193 D	11,300	20.6 D	20,300	1,770 D	2.50 U	1,450	2.50 U	0.500 U	11,100	3,720
SLSWPP	11/16/2010	1,230	2.50 U	18.1	18.1 D	238,000	2.50 U	0.500 U	196 D	12,300	21.9 D	20,500	1,740 D	2.50 U	1,750	2.50 U	0.500 U	11,300	3,810
SLSWP15	11/16/2010	438	2.50 U	16.9	14.9 D	235,000	2.50 U	0.500 U	69.8 D	4,520	7.54 D	20,200	1,710 D	2.50 U	1,730	2.50 U	0.500 U	11,000	3,070
SLSWP14	11/16/2010	435	2.50 U	16.9	16.3 D	239,000	2.50 U	0.500 U	71.5 D	4,560	7.58 D	20,600	1,790 D	2.50 U	1,770	2.50 U	0.500 U	11,300	3,190
SLSWP12	11/16/2010	436	2.50 U	13.7	14.2 D	237,000	2.50 U	0.500 U	55.1 D	3,590	6.05 D	20,500	1,690 D	2.50 U	1,440	2.50 U	0.500 U	11,100	2,940
SLSWP11	11/16/2010	407	2.50 U	13.8	14.5 D	237,000	2.50 U	0.500 U	48.7 D	3,260	5.48 D	20,500	1,700 D	2.50 U	1,450	2.50 U	0.500 U	11,100	2,870
SLSWP10	11/16/2010	134	2.50 U	9.09	0.887 JD	261,000	2.50 U	0.500 U	2.50 U	660	1.52 D	30,800	2,400 D	2.50 U	2,180	5.03 D	0.500 U	10,500	253
SLSWP09	11/16/2010	440	2.50 U	17.0	15.7 D	239,000	2.50 U	0.500 U	68.8 D	4,480	7.01 D	20,800	1,810 D	2.50 U	1,810	2.50 U	0.500 U	11,300	3,320
SLSWP08	11/16/2010	282	2.50 U	16.1	13.4 D	241,000	2.50 U	0.500 U	39.1 D	2,660	4.58 D	21,100	1,720 D	2.50 U	1,870	2.50 U	0.500 U	11,400	2,720
SLSWP07a	11/16/2010	290	2.50 U	13.2	13.1 D	239,000	2.50 U	0.500 U	30.8 D	2,110	3.69 D	21,300	1,650 D	2.50 U	1,640	2.50 U	0.500 U	11,400	2,580
SLSWP07b	11/16/2010	240	2.50 U	16.5	13.1 D	243,000	2.50 U	0.500 U	29.2 D	2,170	4.34 D	21,400	1,600 D	2.50 U	1,930	2.50 U	0.500 U	11,500	2,610
SLSWP06	11/16/2010	197	2.50 U	16.7	12.8 D	247,000	2.50 U	0.500 U	23.5 D	1,860	3.26 D	22,700	1,630 D	2.50 U	2,340	2.50 U	0.500 U	13,000	2,460
SLSWDR6	11/16/2010	185	2.50 U	16.6	12.3 D	247,000	2.50 U	0.500 U	22.8 D	1,740	2.99 D	22,900	1,600 D	2.50 U	2,380	2.50 U	0.500 U	13,200	2,470
Co-located surface water and pore water samples (upstream to downstream)																			
SLSW01	11/17/2010	20.0 U	2.50 U	56.5	0.500 U	66,700	2.50 U	0.500 U	2.50 U	100 U	0.500 U	7,980	4.83 D	2.50 U	776 J	2.50 U	0.500 U	2,350	10.0 U
SLPO01	11/17/2010	2,540	2.50 U	101	1.00 D	70,000	4.24 JD	0.649 JD	15.1 D	6,010	47.8 D	9,440	273 D	2.50 U	1,640	2.50 U	0.584 JD	2,410	115
SLSW02	11/17/2010	20.0 U	2.50 U	58.8	0.500 U	61,300	2.50 U	0.500 U	2.50 U	100 U	0.500 U	7,530	1.21 JD	2.50 U	759 J	2.50 U	0.500 U	2,370	10.0 U
SLPO02	11/17/2010	3,710	7.18 JD	96.6	3.97 D	77,100	4.45 JD	2.25 D	62.1 D	15,800	777 D	9,200	2,680 D	2.50 U	2,110	2.50 U	3.57 D	2,900	414
SLSW03	11/17/2010	24.9 J	2.50 U	58.1	0.500 U	61,500	2.50 U	0.500 U	2.50 U	100 U	0.500 U	7,530	2.17 JD	2.50 U	766 J	2.50 U	0.500 U	2,380	10.0 U
SLPO03	11/17/2010	1,030	4.12 JD	81.4	0.996 JD	63,600	2.50 U	2.87 D	10.2 D	1,660	62.2 D	9,710	277 D	3.86 JD	1,170	2.50 U	1.63 JD	2,370	261
SLSW04	11/17/2010	61.1	2.50 U	56.8	0.500 U	66,500	2.50 U	0.500 U	2.50 U	285	0.788 JD	8,010	69.5 D	2.50 U	797 J	2.50 U	0.500 U	2,630	11.2 J
SLPO04	11/17/2010	1,750	4.44 JD	43.7	0.500 U	199,000	2.50 U	0.500 U	2.50 U	4,190	5.84 D	18,800	872 D	2.50 U	2,030	2.50 U	0.500 U	8,880	29.1
SLSW05	11/17/2010	113	2.50 U	10.7	5.35 D	235,000	2.50 U	0.500 U	2.50 U	100 U	0.693 JD	22,100	1.00 U	2.50 U	1,360	2.50 U	0.500 U	10,700	889
SLPO05	11/17/2010	102	2.50 U	14.8	5.66 D	239,000	2.50 U	0.500 U	2.50 U	147 J	3.18 D	22,400	60.4 D	2.50 U	1,700	2.50 U	0.500 U	10,800	937
Dolores River Surface Water (upstream to downstream)																			
SLDRBG	11/17/2010	57.8	2.50 U	67.8	0.500 U	42,300	2.50 U	0.500 U	2.50 U	100 U	0.500 U	6,460	12.5 D	2.50 U	657 J	2.50 U	0.500 U	2,760	10.0 U
SLDRMZ1a	11/17/2010	41.0 J	2.50 U	62.8	0.545 JD	54,300	2.50 U	0.500 U	2.50 U	100 U	0.500 U	7,590	132 D	2.50 U	875 J	2.50 U	0.562 JD	3,400	34.2
SLDRMZ1b	11/17/2010	61.5	2.50 U	60.3	1.09 D	66,100	2.50 U	0.500 U	2.50 U	209 J	0.500 U	8,570	237 D	2.50 U	974 J	2.50 U	0.500 U	4,000	187
SLDRMZ1c	11/17/2010	87.1	2.50 U	56.2	1.99 D	84,200	2.50 U	0.500 U	2.50 U	373	0.719 JD	10,100	399 D	2.50 U	1,090	2.50 U	0.500 U	4,950	407
SLDRMZ2	11/17/2010	90.7	2.50 U	59.9	1.16 D	65,000	2.50 U	0.500 U	4.90 JD	554	1.16 D	8,460	277 D	2.50 U	951 J	2.50 U	0.500 U	3,940	210
SLSWDR7b	11/16/2010	72.3	2.50 U	60.0	0.882 JD	66,100	2.50 U	0.500 U	2.50 U	256	0.500 U	8,930	218 D	2.50 U	1,140	2.50 U	0.500 U	4,400	143

U Analyte not detected above the method detection limit.
J Data is estimated. Value is greater than or equal to the method detection limit but less than the practical quantitation limit.
D Sample was diluted prior to analysis.
µg/L micrograms per liter
mg/L milligrams per liter

TABLE 5
Soil and Sediment Metals Concentrations

STATION_ID	Aluminum (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Zinc (mg/kg)
Consensus-Based Risk Concentrations for Comparison to Sediment Sample Results[x]																		
PEC	--	33	--	4.98	--	111	--	149	--	128	--	--	48.6	--	--	--	--	459
TEC	--	9.79	--	0.99	--	43.4	--	31.6	--	35.8	--	--	22.7	--	--	--	--	121
Sediment Samples																		
SLSE02	238 D	**37.3 D**	30.2 D	**33.5 D**	298,000 D	2.55 U	0.509 U	**42.7 D**	2,210 D	23.2 D	2,360 D	1,350 D	2.55 U	327 JD	2.82 JD	0.509 U	493 D	**7,090 D**
SLSE04	7,590 D	**156 D**	107 D	**16.4 D**	120,000 D	7.79 D	9.11 D	**92.9 D**	45,200 D	**335 D**	6,400 D	1,940 D	9.34 D	1,230 D	2.50 U	6.260 D	492 D	**1,560 D**
SLSE05	5,530 D	3.32 D	101 D	**3.16 D**	5,150 D	1.28 D	5.04 D	**174 D**	12,800 D	18.5 D	3,210 D	433 D	3.39 D	698 D	0.500 U	0.158 JD	126 U	**1,330 D**
SLSE10	8,770 D	**56.6 D**	114 D	**54.7 D**	83,100 D	5.22 D	17.4 D	**576 D**	91,600 D	**574 D**	3,230 D	21,700 D	14.4 D	952 D	40.2 D	4.06 D	125 U	**6,620 D**
SLSO13-06*	24,700 D	**23.7 D**	37.5 D	**28.0 D**	11,300 D	15.3 D	9.38 D	**2,790 D**	382,000 D	**924 D**	1,190 D	3,120 D	13.6 D	343 JD	3.35 JD	2.83 D	249 U	**8,590 D**
SLSE15	16,600 D	**20.1 D**	316 D	**471 D**	15,500 D	5.72 D	172 D	**3,310 D**	184,000 D	**314 D**	1,810 D	98,700 D	**129 D**	644 U	5.17 D	2.25 JD	644 U	**91,700 D**
SLSE18-06	18,900 D	**22.4 D**	71.2 D	**138 D**	13,000 D	9.48 D	15.1 D	**3,400 D**	197,000 D	**699 D**	2,410 D	6,390 D	18.6 D	864 D	3.53 JD	5.08 D	123 U	**28,000 D**
SLSEPP-06	14,800 D	**21.8 D**	270 D	**359 D**	13,600 D	5.85 D	153 D	**2,990 D**	152,000 D	**397 D**	2,550 D	82,400 D	**97.3 D**	635 U	5.89 D	4.33 D	635 U	**74,700 D**
Superfund Chemical Data Matrix Standards for Comparison to Soil Sample Results																		
Industrial Soil	990,000	1.6	190,000	800	--	1,400	300	41,000	720,000	800	--	23,000	20,000	--	5,100	5,100	--	310,000
Groundwater Protection – Risk Based	55,000	0.0013	300	1.4	--	--	0.49	51	640	--	--	57	48	--	0.95	1.6	--	680
Groundwater Protection – MCL Based	--	0.29	82	0.038	--	180,000	--	46	--	14	--	--	--	--	0.26	--	--	--
Soil Samples																		
SLSO01-08	2,150 D	**19.3 D**	26.8 D	5.09 D	371 D	3.66 JD	8.05 D	555 D	171,000 D	**2,210 D**	814 D	259 D	11.6 D	1,140 D	2.75 JD	15.3 D	122 U	922 D
SLSO02-06	3,750 D	**11.2 D**	20.5 D	1.88 D	2,020 D	7.86 D	8.67 D	281 D	81,000 D	**1,470 D**	2,480 D	537 D	15.2 D	803 D	2.43 U	7.06 D	121 U	355 D

x Consensus-based values from MacDonald et. al 2000.
PEC Probable effect concentration.
TEC Threshold effect concentration.
mg/kg Concentrations in milligrams per kilogram dry weight
U Analyte not detected above the method detection limit.
J Data is estimated. Value is greater than or equal to the method detection limit but less than the practical quantitation limit.
D Sample was diluted prior to analysis.
Shaded cells indicate the concentration exceeds the risk-based or MCL-based soil screening level for protection of groundwater provided in the Superfund Chemical Data Matrix.
Bold values indicate the concentration exceeds the industrial soil screening level provided in the Superfund Chemical Data Matrix.
* Sample was re-classified as a sediment sample after sample collection because it was collected from the bottom of a pond even though the pond was currently empty.

TABLE 6
QA/QC Sample Results and Relative Percent Difference – Dissolved Metals in Water

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Hardness (mg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (µg/L)	Total Alkalinity (mg $CaCO_3$/L)	Zinc (µg/L)
SLSWFB	20.0 U	2.50 U	2.00 U	0.500 U	100 U	2.50 U	0.500 U	2.50 U	2 U	100 U	0.500 U	100 U	1.00 U	2.50 U	250 U	2.50 U	0.500 U	250 U	5.00 U	10.0 U
SLDRBG	20.0 U	0.500 U	67.2	0.100 U	42,500	2.95	0.100 U	0.500 U	133	100 U	0.100 U	6,430	11.3	0.500 U	651 J	0.892 J	0.116 J	2,730	94.7	10.0 U
SLDRBG DUP	20.0 U	2.50 U	67.3	0.500 U	42,400	5.45 D	0.500 U	4.19 JD	132	100 U	0.500 U	6,410	11.1 D	2.50 U	632 J	2.50 U	1.75 JD	2,760	96.2	10.0 U
RPD	--	--	0.15	--	0.24	**59.5**	--	--	0.75	--	--	0.31	1.79	--	2.96	--	**175.1**	1.09	1.57	--
SLSWDR3	110	2.50 U	17.6	16.3 D	241,000	5.10 D	0.599 JD	9.17 D	687	2,830	0.500 U	20,400	1,760 D	2.50 U	1,750	2.50 U	0.500 U	11,100	105	3,580
SLSWDR4	102	5.00 U	17.8	16.8 D	241,000	5.00 U	1.00 U	11.7 D	687	2,860	1.00 U	20,400	1,830 JD	5.00 U	1,740	5.00 U	1.31 JD	11,100	103	3,630
RPD	7.55	--	1.13	3.02	0	--	--	24.3	0	1.05	--	0	3.90	--	0.57	--	--	0	1.92	1.39
SLSWDR7b	24.2 J	2.50 U	60.4	0.647 JD	67,500	4.91 JD	0.500 U	2.50 U	206	100 U	0.500 U	8,960	205 D	2.50 U	1,130	2.50 U	0.500 U	4,390	110	143
SLSWDR7c	22.5 J	2.50 U	59.5	0.551 JD	67,300	5.70 D	0.500 U	2.50 U	205	100 U	0.500 U	8,910	210 D	2.50 U	1,130	2.50 U	0.500 U	4,360	111	70.6
RPD	7.28	--	1.5	16.03	0.30	14.9	--	--	0.49	--	--	0.56	2.41	--	0	--	--	0.69	0.90	**67.8**

U — Analyte not detected above the method detection limit.
J — Data is estimated. Value is greater than or equal to the method detection limit but less than the practical quantitation limit.
D — Sample was diluted prior to analysis.
RPD — Relative Percent Difference calculated as (C1 – C2)/[(C1+C2)/2] * 100 where C1 and C2 are the duplicate sample concentrations. RPD values greater than 20 percent are shown in bold.
µg/L — micrograms per liter
mg/L — milligrams per liter

TABLE 7
QA/QC Sample Results and Relative Percent Difference – Total Metals in Water

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Silver (µg/L)	Sodium (µg/L)	Zinc (µg/L)
SLSWFB	20.0 U	2.50 U	2.00 U	0.500 U	100 U	2.50 U	0.500 U	2.50 U	100 U	0.500 U	100 U	1.00 U	2.50 U	250 U	2.50 U	0.500 U	250 U	10.0 U
SLDRBG	57.8	2.50 U	67.8	0.500 U	42,300	2.50 U	0.500 U	2.50 U	100 U	0.500 U	6,460	12.5 D	2.50 U	657 J	2.50 U	0.500 U	2,760	10.0 U
SLDRBG DUP	53.9	2.50 U	68.6	0.533 JD	42,600	2.50 U	0.500 U	2.50 U	100 U	1.11 D	6,510	12.6 D	2.50 U	654 J	2.50 U	1.12 JD	2,780	10.0 U
RPD	6.98	--	1.17	--	0.71	--	--	--	--	--	0.77	0.80	--	0.46	--	--	0.72	--
SLSWDR3	1,170	2.50 U	16.2	19.0 D	237,000	2.50 U	0.500 U	193 D	11,300	20.6 D	20,300	1,770 D	2.50 U	1,450	2.50 U	0.500 U	11,100	3,720
SLSWDR4	1,150	2.50 U	18.4	19.6 D	239,000	2.50 U	0.500 U	207 D	11,700	21.0 D	20,600	1,790 D	2.50 U	1,770	2.50 U	1.08 JD	11,300	3,770
RPD	1.72	--	12.72	3.11	0.84	--	--	7.00	3.48	1.92	1.47	1.12	--	19.88	--	--	1.79	1.34
SLSWDR7b	72.3	2.50 U	60.0	0.882 JD	66,100	2.50 U	0.500 U	2.50 U	256	0.500 U	8,930	218 D	2.50 U	1,140	2.50 U	0.500 U	4,400	143
SLSWDR7c	56.3	2.50 U	60.3	0.777 JD	66,900	2.50 U	0.500 U	2.50 U	208 J	0.500 U	9,030	209 D	2.50 U	1,150	2.50 U	0.500 U	4,430	142
RPD	**24.88**	--	0.50	12.66	1.20	--	--	--	**20.69**	--	1.11	4.22	--	0.87	--	--	0.68	0.70

U Analyte not detected above the method detection limit.
J Data is estimated. Value is greater than or equal to the method detection limit but less than the practical quantitation limit.
D Sample was diluted prior to analysis.
RPD Relative Percent Difference calculated as $(C1 – C2)/[(C1+C2)/2] * 100$ where C1 and C2 are the duplicate sample concentrations. RPD values greater than 20 percent are shown in bold.
µg/L micrograms per liter
mg/L milligrams per liter

TABLE 8
QA/QC Sample Results and Relative Percent Difference – Total Metals in Soil/Sediment

STATION_ID	Aluminum (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Calcium (mg/kg)	Chromium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Sodium (mg/kg)	Zinc (mg/kg)
SLSE15	16,600 D	20.1 D	316 D	471 D	15,500 D	5.72 D	172 D	3,310 D	184,000 D	314 D	1,810 D	98,700 D	129 D	644 U	5.17 D	2.25 JD	644 U	91,700 D
SLSE15D	12,900 D	18.6 D	364 D	489 D	15,900 D	4.21 JD	205 D	2,640 D	144,000 D	285 D	1,630 D	118,000 D	137 D	1,290 U	6.28 D	1.96 JD	1,290 U	98,500 D
RPD	25.08	7.75	14.1	3.75	2.55	30.4	17.5	22.5	24.4	9.68	10.5	17.8	6.02	--	19.4	13.8	--	7.15

U Analyte not detected above the method detection limit.
J Data is estimated. Value is greater than or equal to the method detection limit but less than the practical quantitation limit.
D Sample was diluted prior to analysis.
RPD Relative Percent Difference calculated as (C1 – C2)/[(C1+C2)/2] * 100 where C1 and C2 are the duplicate sample concentrations. RPD values greater than 35 percent are shown in bold.
Mg/kg milligrams per kilogram

TABLE 9
Select Water Quality Standards (WQS) for Dolores River Stream Segment 3
(Concentrations in micrograms per liter [μg/L])

Parameter	WQS	WQS at Hardness = 247 mg/L
Cadmium	Acute (trout) = $(1.136672-[\ln(hardness)*0.041838)])*e^{0.9151[\ln(hardness)]-3.6236}$ Chronic = $(1.101672-[\ln(hardness)*0.041838)])*e^{0.7998[\ln(hardness)]-4.4451}$	Acute = 3.74 Chronic = 0.84
Copper	Acute = $e^{0.9422[\ln(hardness)]-1.7408}$ Chronic = $e^{0.8545[\ln(hardness)]-1.7428}$	Acute = 31.5 Chronic = 19.4
Iron	Chronic = 1,000	Chronic = 1,000
Lead	Acute = $(1.46203-[\ln(hardness)*0.145712)])*e^{1.273[\ln(hardness)]-1.46}$ Chronic = $(1.46203-[\ln(hardness)*0.145712)])*e^{1.273[\ln(hardness)]-4.705}$	Acute = 170 Chronic = 6.6
Manganese	Acute = $e^{0.3331[\ln(hardness)]+6.4676}$ Chronic = $e^{0.3331[\ln(hardness)]+5.8743}$	Acute = 4,040 Chronic = 2,230
Zinc	Acute = $0.978e^{(0.8525[\ln(hardness)] + 1.0617)}$ Chronic = $0.986e^{(0.8525[\ln(hardness)] + 0.9109)}$	Acute = 310 Chronic = 269

Water Quality Standards from 5 CCR 1002-31 (Colorado Code of Regulations (CCR) 2010) and 5 CCR 1002-34 (CCR 2011).
mg/L milligrams per liter

TABLE 10
Cumulative Percent Concentration Reduction of Dissolved Metals, Alkalinity, and Hardness in St. Louis Settling Ponds

	Aluminum	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Hardness	Iron	Magnesium	Manganese	Potassium	Sodium	Total Alkalinity	Zinc
Pond 15	69.4%	5.1%	19.0%	-2.1%	27.1%	100%	100%	-1.9%	100%	-1.0%	-1.7%	-1.1%	-2.7%	3.8%	21.2%
Pond 14	79.0%	4.0%	25.8%	-1.2%	39.6%	100%	100%	-1.2%	100%	-1.5%	1.1%	-0.6%	-2.7%	4.8%	23.2%
Pond 12	73.7%	5.1%	24.5%	-1.2%	33.5%	100%	100%	-1.0%	100%	-1.5%	2.8%	-1.7%	-0.9%	4.9%	25.1%
Pond 11	73.5%	6.8%	27.6%	-0.8%	50.0%	100%	100%	-0.7%	100%	-1.0%	1.7%	-1.1%	-0.9%	93.3%	27.9%
Pond 9	70.9%	9.1%	30.1%	-1.2%	40.8%	100%	100%	-1.2%	100%	-2.0%	4.5%	-1.7%	-0.9%	3.8%	29.6%
Pond 8	67.8%	8.5%	25.8%	-2.1%	26.7%	100%	100%	-2.2%	100%	-4.4%	4.0%	-6.9%	-2.7%	-1.0%	28.8%
Pond 7	72.4%	8.0%	30.7%	-2.9%	22.9%	100%	100%	-3.1%	100%	-5.4%	4.5%	-9.7%	-3.6%	-5.7%	28.8%
Pond 7	76.9%	10.8%	30.7%	-2.9%	23.5%	100%	100%	-3.1%	100%	-5.9%	4.0%	-10.9%	-4.5%	-3.8%	29.6%
Pond 6	76.0%	6.3%	29.4%	-5.8%	13.9%	100%	100%	-6.4%	100%	-13.2%	2.8%	-33.1%	-18.0%	-21.0%	31.3%
Pond 5	66.0%	5.7%	32.5%	-5.4%	-11.4%	100%	100%	-6.3%	100%	-13.2%	8.0%	-35.4%	-18.9%	-23.8%	30.4%

Net concentration reduction from adit discharge water (SLSWDR3) to effluent of the listed pond is shown.
Negative values indicate an increase in contaminant concentration at the pond effluent relative to the adit discharge water (SLSWDR3).

TABLE 11
Historic and Current Dissolved Metal Concentrations - St. Louis Tunnel Discharge

Location	Date	Arsenic (µg/L)	Cadmium (µg/L)	Copper (µg/L)	Lead (µg/L)	Manganese (µg/L)	Zinc (µg/L)	Hardness (mg/L)
DR-3 – St. Louis Adit, at portal	10/24/1999	--	12	10 U	1.4	2,200	6,650	490
	10/25/1999	--	12	10 U	1.4	2,200	6,650	689
	6/26/2000	--	18	30	0.5 U	2,660	3,600	639
	6/27/2001	--	21.8	20 B	0.1 U	2,300	4,510	685
	10/18/2001	--	15.7	20 B	0.1 U	2,150	3,560	685
	7/16/2002	--	13 B	20	16.7	2,050	3,430	742
	10/8/2002	--	13.8	22	13.2	1,830	2,970	762
	10/30/2003	--	21.3	20.6	0.1 U	2,170	5,190	730
	12/2/2003	--	22	8.2	0.1 B	1,930	4,000	687
	1/7/2004	--	16.7	14.1	0.2 U	1,820	3,550	716
	2/3/2004	--	17.7	29.5	0.1 U	1,780	3,450	707
	3/2/2004	--	15.6	28	0.119 B	1,850	3,320	729
	4/27/2004	--	20.0	27.3	0.1 U	1,830	4,180	738
	6/1/2004	--	80.4	217	0.101 B	4,320	13,900	724
	7/6/2004	--	35.9	18.6 B	0.1 U	2,750	5,700	613
	12/7/2004	0.8 B	24.5	18.5	0.1 U	2,230	4,200	680
	6/2/2010+	4.4 U	52	91	2.6 U	2,400	7,700	670
	11/16/2010*	2.5 U	16.3	9.17	0.5 U	1,760	3,580	687

Data provided by ARCO/SEH except as noted. Water Quality Data_Rico, Colorado_6 Sep 05_1.xls, A. Jewell. SEH, Inc.
+ Data from Letter Report for Rico-Argentine St. Louis Tunnel Site, Rico, Dolores County, Colorado. From Bryan Williams, URS Operating Services, Inc. to Mr. Steven Way, On-Scene Coordinator, Environmental Protection Agency. August 18, 2010.
* Data from this report
-- No data available
U Analyte not detected at or above the detection limit
µg/L micrograms per liter
B Value is an estimated quantity
mg/L milligrams per liter

TABLE 12
Historic and Current Dissolved Metal Concentrations - St. Louis Ponds Outfall

Location	Date	Arsenic (µg/L)	Cadmium (µg/L)	Copper (µg/L)	Lead (µg/L)	Manganese (µg/L)	Zinc (µg/L)	Hardness (mg/L)
DR-6 - St. Louis Ponds Outfall 002 Discharge	10/24/1999	--	8.7	10 U	0.9	1,700	2,990	--
	6/26/2000	--	5.9	10 U	0.5 U	1,970	1,410	793
	6/27/2001	--	12.5	10 U	0.1 U	1,940	2,470	807
	8/30/2001	--	7.4	10 U	0.9	1,380	1,820	812
	10/18/2001	--	7.7	10 U	0.1 U	1,560	1,660	773
	7/16/2002	--	3 U	3 B	0.2 U	505	410	925
	10/8/2002	--	1.7	--	0.1 U	296	400	848
	10/30/2003	--	4.6	9.7	0.1 B	685	1,110	905
	12/2/2003	--	15.5	3.1	0.1 U	1,930	2,880	802
	1/7/2004	--	11	3 B	0.2 U	1,750	2,420	749
	2/3/2004	--	10.8	3.1	0.1 U	1,690	2,090	787
	3/2/2004	--	8.47	3.15 B	0.1 U	1,720	1,740	763
	4/27/2004	--	7.73	9.5 B	0.1 U	1,070	1,690	817
	6/1/2004	--	45.8	1.5 U	1.2221 B	2,770	8,340	875
	7/6/2004	--	14.9	1.5 U	0.3435 B	1,460	3,080	820
	12/7/2004	1.4 B	15	7.6	0.2 B	2,080	3,140	732
	6/2/2010+	4.4 U	31	3.5 B	2.6 U	2,400	3,900	740
	11/16/2010	2.5 U	11	2.5 U	0.5 U	1,620	2,490	730

Data provided by ARCO/SEH except as noted. Water Quality Data_Rico, Colorado_6 Sep 05_1.xls, A. Jewell. SEH, Inc.
+ Data from Letter Report for Rico-Argentine St. Louis Tunnel Site, Rico, Dolores County, Colorado. From Bryan Williams, URS Operating Services, Inc. to Mr. Steven Way, On-Scene Coordinator, Environmental Protection Agency. August 18, 2010.
* Data from this report
-- No data available
U Analyte not detected at or above the detection limit
µg/L micrograms per liter
B Value is an estimated quantity
mg/L milligrams per liter

TABLE 13
Comparison of Results to Water Quality Standards[1] and Water Quality Based Effluent Limits[2]

	Hardness	Dissolved Cadmium Concentration (µg/L)	Total Iron Concentration (µg/L)	Dissolved Lead Concentration (µg/L)	Dissolved Manganese Concentration (µg/L)	Dissolved Zinc Concentration (µg/L)
Acute WQS	--	3.74	--	170	4,040	310
Chronic WQS	--	0.84	1,000	6.6	2,230	269
WQBEL	--	2.3	2,719	18.4	6,289	729
Pond System Samples (upstream to downstream)						
SLSWDR3	687	***16.3 D***	***11,300***	0.500 U	1,760 D	***3,580***
SLSWPP	694	***16.4 D***	***12,300***	0.500 U	1,780 D	***3,530***
SLSWP15	700	***13.2 D***	***4,520***	0.500 U	1,790 D	***2,820***
SLSWP14	695	***12.1 D***	***4,560***	0.500 U	1,740 D	***2,750***
SLSWP12	694	***12.3 D***	***3,590***	0.500 U	1,710 D	***2,680***
SLSWP11	692	***11.8 D***	***3,260***	0.500 U	1,730 D	***2,580***
SLSWP10	804	0.500 U	660	0.500 U	2,230 D	**261**
SLSWP09	695	***11.4 D***	***4,480***	0.500 U	1,680 D	***2,520***
SLSWP08	702	***12.1 D***	**2,660**	0.500 U	1,690 D	***2,550***
SLSWP07a	708	***11.3 D***	**2,110**	0.500 U	1,690 D	***2,520***
SLSWP07b	708	***11.3 D***	**2,170**	0.500 U	1,680 D	***2,550***
SLSWP06	731	***11.5 D***	**1,860**	0.500 U	1,710 D	***2,460***
SLSWDR6	730	***11.0 D***	**1,740**	0.500 U	1,620 D	***2,490***
Co-located surface water and pore water samples (upstream to downstream)						
SLSW01	201	0.500 U	100 U	0.500 U	5.48 D	10.0 U
SLPO01	203	0.500 U	***6,010***	0.500 U	30.9 D	17.1 J
SLSW02	185	0.500 U	100 U	0.500 U	2.03 JD	10.1 J
SLPO02	214	0.500 U	***15,800***	0.529 JD	**2,480 D**	10.0 U
SLSW03	174	0.500 U	100 U	0.500 U	1.00 U	10.0 U
SLPO03	186	0.500 U	**1,660**	**5.28 D**	6.59 D	131
SLSW04	201	0.500 U	285	0.500 U	45.6 D	10.0 U
SLPO04	643	0.500 U	***4,190***	0.500 U	1,050 D	10.9 J
SLSW05	665	***4.76 D***	100 U	0.500 U	1.00 U	***918***
SLPO05	686	***2.87 D***	147 J	0.500 U	176 D	**580**
Dolores River Surface Water (upstream to downstream)						
SLDRBG	133	0.100 U	100 U	0.100 U	11.3	10.0 U

TABLE 13
Comparison of Results to Water Quality Standards[1] and Water Quality Based Effluent Limits[2]

	Hardness	Dissolved Cadmium Concentration (µg/L)	Total Iron Concentration (µg/L)	Dissolved Lead Concentration (µg/L)	Dissolved Manganese Concentration (µg/L)	Dissolved Zinc Concentration (µg/L)
SLDRMZ1a	167	0.500 U	100 U	0.500 U	126 D	30.5
SLDRMZ1b	199	**0.736 JD**	209 J	0.500 U	224 D	176
SLDRMZ1c	248	**1.87 D**	373	0.500 U	361 D	**390**
SLDRMZ2	200	0.513 JD	554	0.500 U	224 D	173
SLSWDR7b	206	0.647 JD	256	0.500 U	205 D	143

1 Water quality standards (WQS) calculated at hardness = 247 mg/L
2 Water quality based effluent limits (WQBEL) are those proposed in the State Water Quality Assessment, October 2008
Bold values exceed chronic water quality standards
Shaded values exceed both acute and chronic water quality standards
Italic values exceed the WQBEL
µg/L micrograms per liter
mg/L milligrams per liter

APPENDIX A

Photolog

PHOTO 1
Downstream of sample location SLSWDR3 where water enters piping to Pond 15.

PHOTO 2
Sample location SLSWDR3.

PHOTO 3

Sample location SLSWPP. Sample collected from discharge of pipe that carries water from below the DR-3 flume into Pond 15.

PHOTO 4

Sample location SLSWP15. Sample collected from ponded water below lower pipe that carries water from Pond 15 into Pond 14.

PHOTO 5
Sample location SLSWP15. Sample collected from ponded water below lower pipe that carries water from Pond 15 into Pond 14.

PHOTO 6
Bucket shows freeboard in Pond 15.

PHOTO 7

Sample location SLSWP14. Sample collected from rock lined outfall channel from Pond 14 to Pond 12.

PHOTO 8
Sample location SLSWP12 collected in overflow channel between Pond 12 and Pond 11.

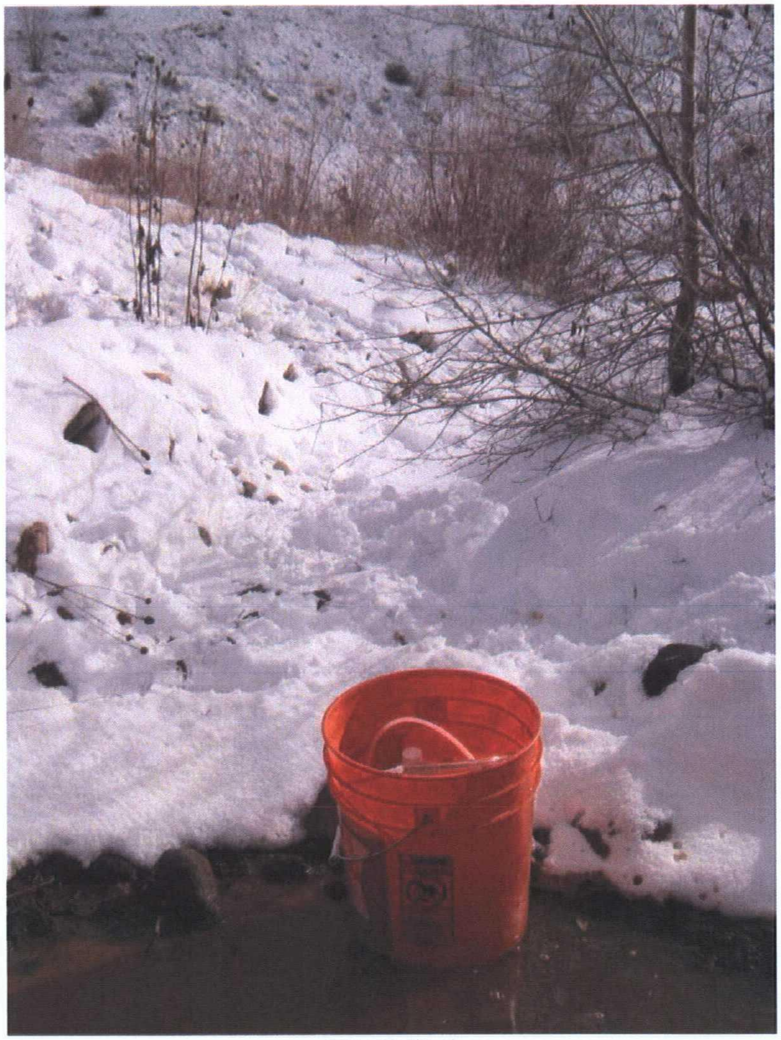

PHOTO 9
Six to eight inches of freeboard in the southeast corner of Pond 14 at the overflow channel to pond 13.

PHOTO 10

Sample location SLSWP11 collected from pipe flowing from Pond 11 into Pond 9.

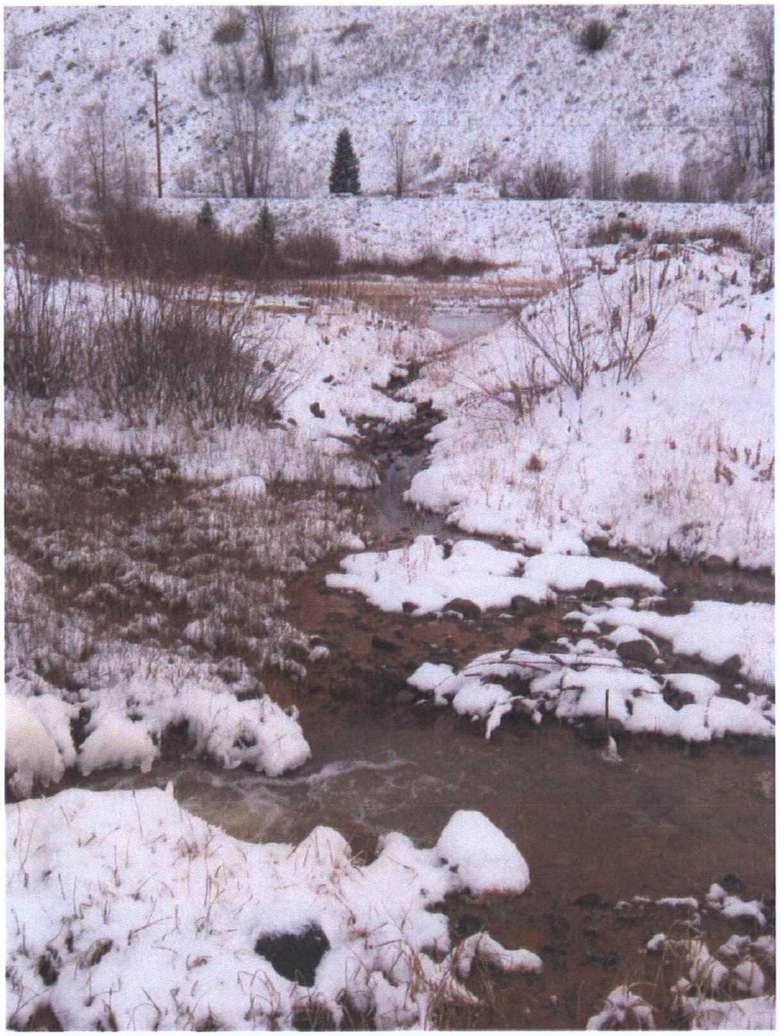

PHOTO 11

Sample location SLSWP10. Sample collected in channel between Pond 10 and Pond 9 near the north end of the ponds. Water is flowing from Pond 10 into Pond 9.

PHOTO 12

Sample location SLSWP10 facing south. Sample collected in channel between Pond 10 and Pond 9 near the north end of the ponds. Water is flowing from Pond 10 into Pond 9.

PHOTO 13
Sample SLSWP09 collected in open channel between Pond 9 and Pond 8.

PHOTO 14

Sample location SLSWP08 collected in overflow channel from Pond 8 into Pond 7.

PHOTO 15

Sample SLSWP07A located collected as water discharges from Pond 7 through pipes into to Pond 6.

PHOTO 16
Sample location SLSWP07B located at southeast corner of Pond 7 as water discharges in rock lined channel to Pond 6.

PHOTO 17
Sample location SLSWP06

PHOTO 18
Sample location DR-6. Flume adjacent to shed downstream of Pond 15 and upstream of pond outfall.

PHOTO 19
Sample location SLSW01/SLPO01. Sample collected in wetland channel north of ponds.

PHOTO 20
Sample location SSLSW02/SLPO02. Sample collected in wetland channel approximately 100 feet south of the north end of Pond 18.

PHOTO 21

Sample location SSLSW02/SLPO02. Sample collected in wetland channel approximately 100 feet south of the north end of Pond 18.

PHOTO 22

Sample location SLSW03/SLPO03. Located in wetland channel west of pond 18.

PHOTO 23
Sample location SLSW04/SLPO04. Collected from approximately 30 feet upstream of the outfall of the wetland channel into the Dolores River.

PHOTO 24
Sample location SLSW05/SLPO05. Sample collected at base of riprap berm on the east side of the southwest corner of Pond 15. The water appeared to be seeping from Pond 15.

PHOTO 25

Sample location SLSWBG. Sample collected in Dolores River upstream of site near site fenceline.

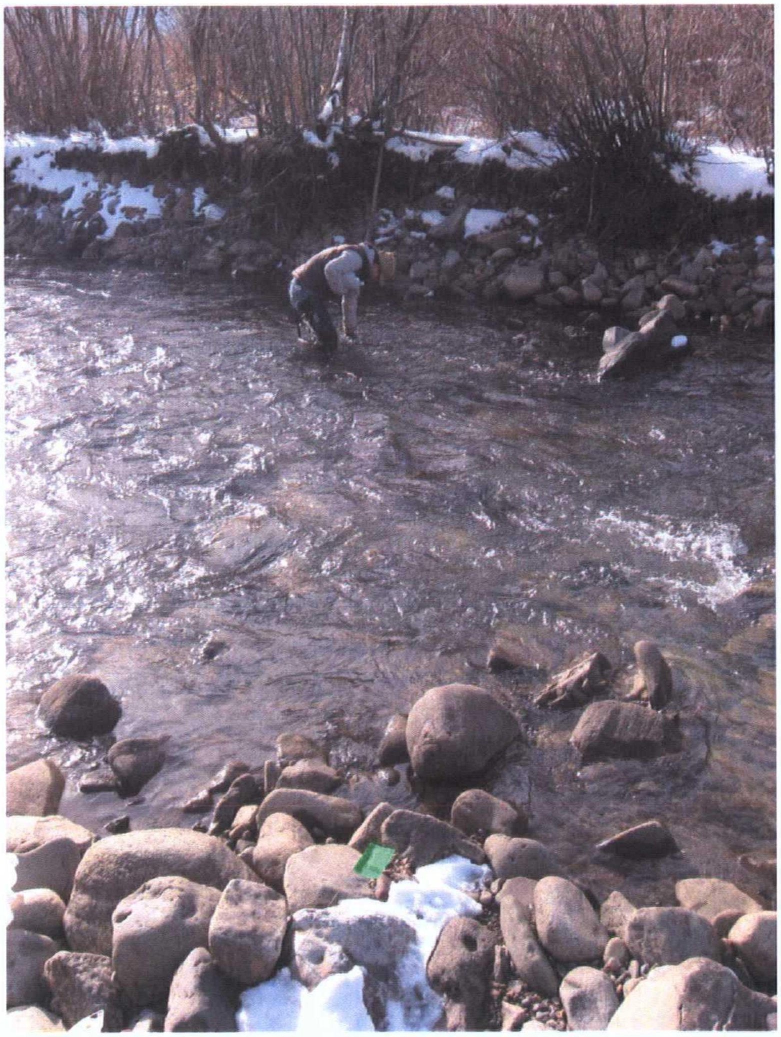

PHOTO 26

Sample location SLDRMZ1. Located in Dolores River approximately 110 feet downstream of pond outfall. Samples collected ¼, ½, and ¾ of distance across river.

PHOTO 27

Sample location SLSWMZ1. Located in Dolores River approximately 110 feet downstream of pond outfall. Samples collected ¼, ½, and ¾ of distance across river.

PHOTO 28

Sample location SLSWMZ2 approximately 230 feet downstream of pond outfall. Sample collected at midpoint in stream.

PHOTO 29
Sample location SLSWMZ2. Sample collected at midpoint in stream.

PHOTO 30
Sample location SLSWDR7B. Sample collected in Dolores River approximately 50 feet downstream of Highway 145 bridge north of Rico.